Improved Cost and Performance of PFAS Groundwater Treatment Using a Carbon-Based Micro-Adsorbent and Ceramic Separations Technology

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Background/Objectives. Granular activated carbon (GAC) treatment is currently the most common approach to remove per- and polyfluoroalkyl substances (PFAS) from water, especially perfluorooctane sulfonic acid (PFOS) and perfluorooctanic acid (PFOA). Recent studies have shown relatively short breakthrough times for certain PFAS when using GAC and there is a significant need to develop more cost-effective treatment solutions for the removal of a broad-range of PFAS (e.g., short-chain perfluoroalkyl acids [PFAAs] and precursors). As part of its FY2019 statement of need, the Environmental Security Technology Certification Program (ESTCP) solicited input to address this gap. As a result, a recent collaboration between Aqua-Aerobic Systems, Inc. (AASI) and the Colorado School of Mines evaluated the use of its AquaPRS technology which uses a carbon-derived, super-fine sorbent media in conjunction with a robust micro-filtration system to remove PFAS from various contaminated water sources. Initial laboratory studies indicated that AquaPRS system exhibited a significantly higher sorption capacity (> 2,000 times) for certain PFAS compared to conventional GAC.

Approach/Activities. The AquaPRS system was applied to a combined groundwater/surface water treatment system at Horsham Air Guard Station and a groundwater system at Willow Grove Naval Air Station. AASI's mobile treatment unit was operated with two separate treatment trains on a slip stream from existing PFAS treatment systems: the first was operated at a steady state to evaluate PFAS breakthrough, while the second was operated dynamically changing sorbent concentrations to optimize the performance of the system. Final optimization trials were also completed using the two reactors in series to evaluate total PFAS removal. The objective was to demonstrate and validate the application of the novel sorbent material to reduce the total life cost reduction of PFAS-impacted water treatment by: 1) evaluating broad spectrum and short-chain PFASs treatment selectivity; and 2) evaluating cost and performance requirements related to concentration and treatment of the retentate.

Results/Lessons Learned. Specific adsorbance of PFOA and PFOS was more than 200 and 400 times greater with the AquaPRS sorbent when compared to GAC for the Horsham site and 200 and 1,600 times higher again at Willow Grove, respectively. The demonstration verified sorbent concentration methods to reduce waste volumes and costs. Cloth media filtration technology was demonstrated as a means to effectively reduce sediment loading from the Horsham surface water outfall ahead of PFAS treatment. Combined with automated operation, the AquaPRS approach could lead to significant OPEX reductions of up to 90% of GAC at Horsham with payback on increased CAPEX for the CMF in approximately 3 months. The Willow Grove demonstration showed effective treatment with single-stage treatment and further reductions of combined UCMR3 compounds (PFOA, PFOS, PFNA, PFHpA, PFHxS and PFBS) from 40,000 ng/L to < 40 ng/L with two-stage treatment.